alike; it loses its value as soon as we have a more explicit theory which leaves no important fact of psychological optics outstanding. I cannot at all assent to Professor Stevens' assertion that the theory 'has a good following among psychologists.'

M. Nicati's theory is contained in a single forty-page article, which has not as yet received the compliment of an abstract in the *Zeitschrift*, or the *Année psychologique*. M. Nicati and Professor Patten have, as Professor Stevens says (p. 515), a perfect right to the enunciation of their hypotheses if they believe that these add to the intelligibility of the observed facts. But the hypotheses must be worked out in fiftyfold greater detail, and set upon a fiftyfold wider basis of observation and experiment, before they cease to be the private property of their authors and command general attention. The psychologist must know them in the sense that he must know his literature at large. He is no more disturbed by them, however, than is the biologist by the thousand and one theories of heredity and transmission that have been formulated since the days of pangenesis.*

In conclusion, I must ask Professor Stevens and other readers to excuse the dogmatic tone of this communication and to attribute it to limitations of space. References could be given for every statement. I may add that my own conversion to the Hering theory has been exceedingly gradual, the result of a systematic working through of argument and counter-argument, under experimental control; and that, so far as I am aware, I have absolutely no bias in favor of any theory There are three or four other theories of vision, not mentioned in these two papers, which I should rate higher than either that of M. Nicati or that of Professor Patten. Psychologists should be grateful to Professor Stevens, not only for raising a general question which concerns both physics and psychology, but for his 'physical' criticisms upon the Helmholtz theory.

E. B. TITCHENER.

* M. Nicati's hypothesis posits a primary gray-vision, and proceeds with a tri-component color theory on an electrical-physiological basis. It is apparently a remote offshoot of the Helmholtz theory.

THE DEBT OF THE WORLD TO PURE SCIENCE.

TO THE EDITOR OF SCIENCE: Professor Stevenson's admirable address, recently published in SCIENCE, calls to mind the sometimes forgotten fact that there are still those who in considering the labors of science, scornfully ask: "What is the use of all this?" Of all forms of scientific propagandism the exhibition of specimens in a scientific museum might seem least likely to bear fruit to financial profit. That even here, however, the practical benefits of science can be demonstrated, the following examples that have recently come under my observation may be cited. They are of no great consequence themselves, but illustrate a principle which undoubtedly has wide application and, coming to my notice quite by chance, are probably typical of hundreds of similar instances which occur.

A government contract was to be let for the building of a breakwater. The filling was required to be rock of a certain toughness and durability. The local contractors, with a unanimity born either of accident or design, declared that it would be necessary to go more than a hundred miles to obtain such rock and a railroad would have to be built to transport it. Their estimates of the cost of the work were made accordingly. There was not time for contractors at a distance to explore the region, but one contractor, living two thousand miles away, sent a prospector about in the vicinity of the proposed work, with instructions to forward him samples of such rock as might be suitable for the work, with information as to the quantity of each in sight. These samples the contractor brought to a museum, and by comparison with the specimens there, and consultation with the Curator, learned that one of the rocks collected possessed the required qualities. He also learned that the quantity was probably assured by the fact that it was an eruptive rock of which more could be obtained by deeper quarrying. Relying on this information, he made a bid on the work at a price $75,000 lower than any of the other contractors had done. The information he had gained may be credited with having saved the government that amount.

A company endeavoring to sell stock in a

Western mine distributed, as one of the products of their 'Holy Terror,' specimens which they denominated metallic cobalt. The substance looked metallic enough, and local assayers being unable to deny their statement the shares found ready sale for a while. But after a time one doubting Thomas brought his specimen to a museum to see if by comparison with anything there he could establish its cobaltic character. A little comparison showed him that his specimen was carborundum, and carborundum he learned was not made by the reduction of cobalt ore. Whether he imparted this information to others who thought of purchasing shares I do not know, but it is likely that the output of carborundum from cobalt (?) mines received a serious set-back after his discovery.

A Canadian prospector working in a little-explored region found a deposit which for some reason he believed to be zinc ore. He was so well convinced of this that he made his way to a large city for the purpose of obtaining means to work the ore. Visiting a museum where specimens of zinc ore were exhibited, he compared them with his own and at first concluded that the two were identical. On looking further, however, he saw specimens of septaria, which he at once recognized as representing his own specimens. His dreams of a zinc mine were dissipated, but that the awakening had come before he had expended his own and other's means was due to his improving an opportunity to consult an accurately classified and identified, in other words, a scientific collection.

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Field Columbian Museum.

SCIENTIFIC LITERATURE.

Darwin, and After Darwin. III. Post-Darwinian Questions, Isolation and Physiological Selection. By the late G. J. Romanes. Chicago, Open Court Pub. Co. 1897.

The writings of the late Dr. Romanes are always interesting, whether one agrees with his conclusions or not. The present volume deserves to be widely read by naturalists, not only as a clear exposition of its author's views on evolution, but as an admirable stimulus to thought and observation. Dr. Romanes, in the closing years of his life, did all he could to bring about the foundation of an establishment for testing experimentally the various hypotheses concerning evolution, but without much success. A few observers have been doing excellent work, but the great majority of working naturalists appear to pay little attention to theoretical considerations, and so lose the opportunity of contributing valuable evidence to throw light on controverted questions.

Under the heading of Isolation it is set forth that this may be of two kinds. In *Apogamy*, or indiscriminate isolation, certain individuals are isolated from their fellows without regard for any peculiarities they may possess; in *Homogamy*, on the other hand, the isolated individuals are isolated because they differ from the rest. Natural selection gives rise to *Homogamy* by preserving certain individuals having desirable peculiarities, thus isolating them from those which, lacking those characters, perish. Any form of *Homogamy* must cause a change of type, and thus constitutes a step in evolution. *Apogamy*, strictly speaking, would not cause any change; but as no two portions of a species are entirely alike, in practice it becomes converted into a slight form of *Homogamy* and in time change results. This is most likely to occur when the separated portion is very small, as the average of a few individuals is less likely to resemble that of the whole species than the average of, say, half the species.

It is set forth that there are two forms of evolution, the *monotypic* and the *polytypic*. Natural selection, it is stated, can only cause monotypic evolution; therefore to explain the multiplication of species in space we must call in the aid of other forms of isolation. One potent cause of isolation is said to be *Physiological Selection, i. e.*, the segregation of sets of individuals which are fertile with one another, but wholly or partly sterile with the rest of the species.

All these matters are discussed in detail, with many quotations from previous writings. On p. 41 it is remarked that "against the view that natural selection is a sufficient explanation of the origin of species there are two fatal difficulties: one, the contrast between natural